

## THE CLAIMS

What is claimed is:

1. A golf ball comprising:
  - 5 a core, wherein the core comprises at least one layer formed of a composition comprising at least one rubber, a metal salt of an  $\alpha,\beta$ -unsaturated acid, an initiator, and at least one thermoplastic material having a Vicat-softening temperature of at least about  $38^{\circ}\text{C}$ ;
  - an inner cover disposed about the core; and
  - 10 an outer cover disposed about the inner cover.
2. The golf ball of claim 1, wherein the at least one thermoplastic material has at least one of a hardness of at least about 15 Shore A, a dynamic storage modulus of at least about  $10^4$  dynes/cm<sup>2</sup>, or a loss tangent no greater than 1 at  $23^{\circ}\text{C}$  and a  
15 frequency of 1 Hz.
3. The golf ball of claim 1, wherein the at least one thermoplastic material comprises a thermoplastic elastomer.
- 20 4. The golf ball of claim 3, wherein the thermoplastic elastomer is a block polymer selected from the group consisting of a copoly(ether-ester), copoly(ether-amide), copoly(ester-amide), copoly(urethane-ether), copoly(urethane-ester), maleic anhydride grafted styrene-ethylene-butylene-styrene copolymers, and mixtures thereof.
- 25 5. The golf ball of claim 1, wherein the amount of the at least one thermoplastic material is from about 1 to 50 parts per hundred of the total parts of the rubber.
- 30 6. The golf ball of claim 1, wherein the at least one rubber is selected from the group consisting of polybutadiene, polyisoprene, ethylene-propylene, styrene-butadiene, ethylene-propylene-diene rubber, a polymer of ethylene-propylene diene monomer, styrene-ethylene-butylene-styrene copolymer, and mixtures thereof, including functionalized derivatives thereof.
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7. The golf ball of claim 1, wherein the core has a diameter of about 1.55 inches or less.

8. The golf ball of claim 1, wherein the outer cover comprises a castable reactive liquid material.

9. The golf ball of claim 8, wherein the castable reactive liquid material is cast polyurethane.

10. The golf ball of claim 1, wherein the outer cover has a hardness from about 30 Shore D to about 60 Shore D.

11. The golf ball of claim 1, wherein the outer cover has a thickness from about 0.02 inches to about 0.045 inches.

12. The golf ball of claim 1, wherein the inner cover comprises at least one material selected from the group consisting of ionomers, thermoplastic or thermoset polyurethanes, polyetheresters, polyetheramides, or polyesters, dynamically vulcanized elastomers, functionalized styrene-butadiene elastomers, metallocene polymers, polyamides such as nylons, acrylonitrile butadiene-styrene copolymers (ABS), and blends thereof.

13. The golf ball of claim 1, wherein the inner cover has a thickness from about 0.01 inches to about 0.05 inches.

14. The golf ball of claim 1, wherein the inner cover has a hardness of about 65 Shore D or greater.

15. A golf ball comprising:  
a core comprising at least two layers, wherein at least one of the core layers is formed of a composition comprising at least one rubber, a metal salt of an  $\alpha,\beta$ -unsaturated acid, an initiator, and at least one thermoplastic material having a Vicat-softening temperature of at least about 38°C; and  
an inner cover disposed about the core; and  
an outer cover disposed about the inner cover.

16. The golf ball of claim 15, wherein the at least one thermoplastic material comprises a thermoplastic elastomer.

17. The golf ball of claim 16, wherein the thermoplastic elastomer is a  
5 block polymer selected from the group consisting of a copoly(ether-ester),  
copoly(ether-amide), copoly(ester-amide), copoly(urethane-ether), copoly(urethane-ester),  
maleic anhydride grafted styrene-ethylene-butylene-styrene copolymers, and mixtures  
thereof.

18. The golf ball of claim 15, wherein the at least one thermoplastic  
10 material has at least one of a hardness of at least about 15 Shore A, a dynamic storage  
modulus of at least about  $10^4$  dynes/cm<sup>2</sup>, or a loss tangent no greater than 1 at 23°C and a  
frequency of 1 Hz.

19. The golf ball of claim 15, wherein the amount of the at least one  
15 thermoplastic material is from about 1 to 50 parts per hundred of the total parts of the  
rubber.

20. The golf ball of claim 15, wherein the at least one rubber is selected  
20 from the group consisting of polybutadiene, polyisoprene, ethylene-propylene,  
styrene-butadiene, ethylene-propylene-diene rubber, a polymer of ethylene-propylene diene  
monomer, styrene-ethylene-butylene-styrene copolymer, and mixtures thereof, including  
functionalized derivatives thereof.

21. The golf ball of claim 15, wherein the core has a diameter of about  
25 1.55 inches or less.

22. The golf ball of claim 15, wherein the outer cover comprises a  
castable reactive liquid material.

23. The golf ball of claim 22, wherein the castable reactive liquid  
30 material is cast polyurethane.

24. The golf ball of claim 15, wherein the outer cover has a hardness  
35 from about 30 Shore D to about 60 Shore D.

25. The golf ball of claim 15, wherein the outer cover has a thickness from about 0.02 inches to about 0.045 inches.

26. The golf ball of claim 15, wherein the inner cover comprises at least one material selected from the group consisting of ionomers, thermoplastic or thermoset polyurethanes, polyetheresters, polyetheramides, or polyesters, dynamically vulcanized elastomers, functionalized styrene-butadiene elastomers, metallocene polymers, polyamides such as nylons, acrylonitrile butadiene-styrene copolymers (ABS), and blends thereof.

27. The golf ball of claim 15, wherein the inner cover has at least one of a hardness of about 65 Shore D or greater.

28. The golf ball of claim 15, wherein the inner cover has a thickness from about 0.01 inches to about 0.05 inches.

29. A method of forming a golf ball comprising:  
forming a first mixture comprising at least one rubber and at least one thermoplastic material;  
mixing said first mixture at a first temperature sufficient to allow substantially homogeneous mixing of said first mixture;  
cooling said first mixture to a second temperature;  
forming a second mixture by adding the first mixture to a free-radical initiator having an activation temperature at a temperature above the second temperature; and  
shaping and heating the second mixture to at least the activation temperature to crosslink the second mixture so as to form a portion of a golf ball core;  
forming an inner cover disposed about the golf ball core; and  
forming an outer cover thereon.

30. The method of claim 29, wherein the at least one thermoplastic material comprises a thermoplastic elastomer.